

WHAT IS CLAIMED IS:

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1. A laser for emitting pulsed electromagnetic radiation, said laser comprising:
- an optical resonator;
- 5 a solid-state laser gain medium placed inside said optical resonator, said laser gain medium having two end faces, and at least one of said end faces comprising a cooling surface;
- means for cooling said laser gain medium via said cooling surface;
- means for exciting said laser gain medium to emit electromagnetic radiation;
- and
- 10 means for passive mode locking placed inside said optical resonator.
2. The laser according to claim 1, wherein said laser gain medium is in the shape of a thin plate or layer with two end faces, the extension of said end faces being greater than a thickness of said plate or layer measured essentially in a direction perpendicular to one of said end faces.
- 15 3. The laser according to claim 1, wherein at least one of said end faces is provided with means for reflecting said emitted electromagnetic radiation.
4. The laser according to claim 3, wherein said reflecting means comprise a dielectric coating.

5. The laser according to claim 1, wherein said laser gain medium is selected from the group consisting of Yb:YAG, Nd:YAG, Nd:YVO₄, and a semiconductor material.
- 5 ✓ 6. The laser according to claim 1, wherein said laser gain medium has a thickness such that the effect of spatial hole burning supports the generation of short pulses.
- ✓ 7. The laser according to claim 1, wherein said optical resonator is designed such that said emitted electromagnetic radiation hits said thin-disk gain medium twice during each round-trip in said optical resonator.
- 10 ✓ 8. The laser according to claim 1, wherein said optical resonator is designed such that said emitted electromagnetic radiation hits said thin-disk gain medium more than two times during each round-trip in said optical resonator, whereby at least two hits with different angles of incidence occur such that a standing-wave pattern in said thin-disk gain medium is at least partially smeared out.
- 15 9. The laser according to claim 1, wherein said means for passive mode locking comprise a saturable absorber.
10. The laser according to claim 9, wherein said saturable absorber is a semiconductor saturable absorber mirror device.
- ✓ 11. The laser according to claim 1, wherein said means for passive mode locking
20 comprise means for Kerr lens mode locking.

12. The laser according to claim 1, further comprising means for introducing negative dispersion or dispersion compensation placed inside said optical resonator.
13. The laser according to claim 12, wherein said dispersion-compensating means are a Gires-Tournois interferometer, a pair of diffraction gratings, a pair of prisms, or a dispersive mirror.
14. The laser according to claim 1, wherein said optical resonator has a length such as to emit pulsed electromagnetic radiation at a repetition rate lower than 100 MHz, and preferably lower than 50 MHz.
15. The laser according to claim 1, wherein said exciting means comprise an electromagnetic-radiation source.
16. The laser according to claim 1, further comprising means for cavity dumping.
17. The laser according to claim 1, further comprising means for Q-switched mode locking.
18. An apparatus for emitting pulsed electromagnetic radiation, said apparatus comprising the laser according to claim 1 and means for an optically nonlinear frequency conversion of electromagnetic radiation emitted by said laser.

- 0 19. The apparatus according to claim 18, wherein said frequency-conversion means comprise a synchronously pumped optical parametric oscillator (OPO), a frequency doubler, a sum frequency mixer, an optical parametric generator (OPG), and/or an optical parametric amplifier (OPA).
- 5 20. The apparatus according to claim 19, wherein said frequency-conversion means comprise a synchronously pumped optical parametric oscillator (OPO) and a frequency doubler, a sum frequency mixer, an optical parametric generator (OPG) or an optical parametric amplifier (OPA), for generating pulsed red, green and blue light.
- 10 21. The apparatus according to claim 18, wherein said means for an optically nonlinear frequency conversion comprise an optically nonlinear crystal with defined principal axes, said apparatus further comprising means for adjusting the propagation angle of said laser radiation in said crystal with respect to said principal axes in order to obtain phase matching of the nonlinear conversion process.
- 15 22. A method for generating pulsed laser radiation, comprising the steps of:
- exciting a solid-state laser gain medium to emit electromagnetic radiation, said laser gain medium having two end faces, and at least one of said end faces comprising a cooling surface;
- 20 cooling said laser gain medium via said cooling surface;
- recirculating said electromagnetic radiation in an optical resonator; and
- passively mode locking said electromagnetic radiation.

23. The method according to claim 22, wherein said electromagnetic radiation is mode locked by a saturable absorber and/or by Kerr lens mode locking.
24. The method according to claim 22, wherein negative dispersion is introduced to inside said optical resonator.
- 5 25. The method according to claim 22, wherein pulsed electromagnetic radiation is emitted at a repetition rate lower than 100 MHz, and preferably lower than 50 MHz.
26. The method according to claim 22, wherein said laser gain medium is excited by electromagnetic radiation.
- 10 27. The method according to claim 22, wherein said electromagnetic radiation in said optical resonator is cavity dumped.
- ✓ 28. The method according to claim 22, wherein the thickness of the gain medium is chosen such that the effect of spatial hole burning supports the generation of short pulses.
- 15 ✓ 29. The method according to claim 22, wherein said emitted electromagnetic radiation hits said thin-disk gain medium twice during each round-trip in said optical resonator.

30. The method according to claim 22, wherein said emitted electromagnetic radiation hits said thin-disk gain medium more than two times during each round-trip in said optical resonator, whereby at least two hits with different angles of incidence occur such that a standing-wave pattern in said thin-disk gain medium is at least partially smeared out.
31. The method according to claim 22, wherein said electromagnetic radiation in said optical resonator is Q-switched mode locked, preferably by using a saturable absorber with a large modulation depth.
32. A method for generating pulsed electromagnetic radiation, said method comprising the steps for generating pulsed laser radiation according to claim 22, and further optically nonlinearly converting the frequency of said laser radiation.
33. The method according to claim 32, wherein the frequency of said laser radiation is converted by an optical parametric oscillator (OPO), a frequency doubler, a sum frequency mixer, an optical parametric generator (OPG), and/or an optical parametric amplifier (OPA).
34. The method according to claim 33, wherein said laser radiation is converted by an optical parametric oscillator (OPO) and by a frequency doubler, a sum frequency mixer, an optical parametric generator (OPG) or an optical parametric amplifier (OPA), and thus pulsed red, green and blue light is generated.

0 35. The method according to claim 32, wherein the frequency is converted in an optically nonlinear crystal with defined principal axes, and phase matching of the nonlinear conversion process is obtained by adjusting the propagation angle of said laser radiation in said crystal with respect to said principal axes.

112 5 36. A method for varying by a defined scaling factor the output power of the pulsed electromagnetic radiation emitted by the laser according to claim 1, comprising the steps of:

varying essentially by said scaling factor the power emitted by said exciting means;

10 varying essentially by said scaling factor the area illuminated by said electromagnetic radiation in said laser gain medium; and

varying essentially by said scaling factor the area illuminated by said electromagnetic radiation on said mode-locking means.

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